



INDUSTRIAL TESTING LABORATORY

Report No.

150116-01E

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TEST REPORT

Report Date: 15 May 2015

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

Submitted by: Avery Dennison
Mount Prospect, IL 60056

Test Laboratory: Calcoast - ITL
San Leandro, CA 94577

Products Tested: T-6500 White with digitally printed Yellow (TJ01),
Green (TJ07), Red (TJ08), Blue (TJ05), and Brown (TJ09)
with OL-2000 overlay
TJ09 Brown samples submitted 09 Feb 2015;
all other samples submitted 20 Jan 2015

SUMMARY

Specification: ASTM D4956-13
Sheeting Types IV, Class 1 Backing

6.2	Coefficient of Retroreflection	Passed
6.3	Daytime Color and Luminance	Passed
6.4	Outdoor Weathering	Not Tested
6.5	Colorfastness [Artificial Accelerated Weathering Based]	Passed
6.6	Shrinkage	Passed
6.7	Flexibility	Passed
6.8	Liner Removal	Passed
6.9	Adhesion	Passed
6.10	Impact Resistance	Passed
6.11	Nighttime Color	Passed
	Specular Gloss [†]	Passed
S3.	Artificial Accelerated Weathering	Passed

[†] - Discontinued since -09 version, tested for backward compatibility to previous versions

Written by:

Douglas G. Cummins
Photometric Engineer

Approved by:

Mark A. Evans
Laboratory Director

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.2 Coefficient of Retroreflection

Requirement: ASTM D4956 Table 5 (Type IV Sheeting)
Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)
Projector: Hoffman GPS-102 (Illuminant A, 1.17 fc, 30" diameter)
Sample Area: 8.0 in. x 8.0 in, 0.444 ft² (203 mm x 203 mm, 0.0412 m²)

Coefficient of Retroreflection (R_A) determined by measuring three (3) 8"x8" samples, sampled in accordance with D4956 Section 9.1 by Avery Dennison and mounted on 0.040" thick 6061-T6 aluminum panels, at two rotation angles ($\epsilon=0^\circ$ and $\epsilon=90^\circ$) and averaging. $\epsilon=0^\circ$ arbitrarily defined as orientation parallel to roll direction (see photos).

Tested in accordance to ASTM E810 10.7.1 - since no rotation angle is specified the average of the two orientations ($\epsilon=0^\circ$ and $\epsilon=90^\circ$) is required to meet minimum requirements.

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

0.2° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg (R_A)	Min R_A	0°	90°	Avg (R_A)	Min R_A
TJ01 Yellow	#1	357.3	363.8	360.6	216	139.0	155.1	147.1	108
	#2	333.2	343.2	338.2	216	113.6	146.1	129.9	108
	#3	346.0	338.6	342.3	216	138.0	146.2	142.1	108
	Avg	345.5	348.5	347.0	270	130.2	149.1	139.7	135
TJ07 Green	#1	155.4	158.4	156.9	40	60.6	66.9	63.8	20
	#2	137.3	140.9	139.1	40	49.3	58.3	53.8	20
	#3	147.9	140.4	144.2	40	61.8	55.0	58.4	20
	Avg	146.9	146.6	146.7	50	57.2	60.1	58.7	25
TJ08 Red	#1	123.6	123.7	123.7	52	49.0	52.4	50.7	24
	#2	120.6	115.0	117.8	52	49.7	50.7	50.2	24
	#3	122.7	117.3	120.0	52	49.7	51.4	50.6	24
	Avg	122.3	118.7	120.5	65	49.5	51.5	50.5	30
TJ05 Blue	#1	70.7	73.2	72.0	24	28.1	32.9	30.5	11
	#2	71.8	73.3	72.6	24	27.1	31.2	29.2	11
	#3	76.2	74.4	75.3	24	32.3	31.1	31.7	11
	Avg	72.9	73.6	73.3	30	29.2	31.7	30.5	14
TJ09 Brown	#1	52.3	53.8	53.1	14	18.4	20.9	19.7	6.8
	#2	53.3	53.0	53.2	14	19.7	20.5	20.1	6.8
	#3	50.9	48.9	49.9	14	19.4	19.6	19.5	6.8
	Avg	52.2	51.9	52.0	18	19.2	20.3	19.8	8.5

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.2 Coefficient of Retroreflection (continued)

0.5° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg (R _A)	Min R _A	0°	90°	Avg (R _A)	Min R _A
TJ01 Yellow	#1	263.6	267.0	265.3	88	66.9	68.3	67.6	43
	#2	247.4	251.4	249.4	88	56.4	66.5	61.5	43
	#3	250.5	255.3	252.9	88	64.8	67.7	66.3	43
	Avg	253.8	257.9	255.9	110	62.7	67.5	65.1	54
TJ07 Green	#1	123.2	124.4	123.8	17	28.7	30.2	29.5	8.0
	#2	112.2	111.7	112.0	17	23.8	27.1	25.5	8.0
	#3	114.8	113.8	114.3	17	26.8	26.5	26.7	8.0
	Avg	116.7	116.6	116.7	21	26.4	27.9	27.2	10
TJ08 Red	#1	86.1	88.2	87.2	22	24.1	24.4	24.3	10
	#2	85.7	88.5	87.1	22	23.4	23.3	23.4	10
	#3	86.3	88.2	87.3	22	23.8	23.3	23.6	10
	Avg	86.0	88.3	87.2	27	23.8	23.7	23.7	13
TJ05 Blue	#1	56.9	58.4	57.7	10	13.0	14.0	13.5	4.8
	#2	57.8	58.9	58.4	10	12.6	14.6	13.6	4.8
	#3	58.8	60.1	59.5	10	13.6	14.8	14.2	4.8
	Avg	57.8	59.1	58.5	13	13.1	14.5	13.8	6.0
TJ09 Brown	#1	37.6	37.5	37.6	6.0	9.2	9.5	9.4	2.8
	#2	37.4	37.9	37.7	6.0	9.5	9.7	9.6	2.8
	#3	36.8	37.0	36.9	6.0	9.2	8.7	9.0	2.8
	Avg	37.3	37.5	37.4	8.0	9.3	9.3	9.3	3.5

Individual sample's Coefficient of Retroreflection may be 80% of required so long as average of three samples meets minimum requirement.

Products meet Coefficient of Retroreflection requirements for Type IV Sheeting.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.3 Daytime Color and Luminance

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)
Test Method: ASTM E308, E1347, E1349, E991, E1164
(Illuminant D65, 2° Observer, Annular 45/0 Geometry)
Average of 8 reads, each read oriented 45° apart
Instrument: Hunterlab Colorflex A60 Spectrocolorimeter (No SCF available)

Product	x	y	Y		
			Measured	Minimum	Maximum
TJ01 Yellow	0.4578	0.4830	33.23	15	45
TJ07 Green	0.1579	0.4692	9.10	3.0	12
TJ08 Red	0.6301	0.3295	8.04	2.5	15
TJ05 Blue	0.1548	0.1320	5.07	1.0	10
TJ09 Brown	0.4869	0.4008	3.52	1.0	9.0

Products meet Daytime Color and Luminance requirements.

6.4 Accelerated Outdoor Weathering

Requirement: 80% of ASTM D4956 Table 5 (Type IV),
0.2° observation only
Test Method: Exposure: ASTM G7, 36 months, AZ & FL, Direct 45° South
exposure, open backing
Reflex: ASTM E810

Not tested

6.5 Colorfastness

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)
Test Method: Exposure: ASTM G7, 36 months, AZ & FL, Direct 45° South
exposure, open backing
Color: ASTM E308, E1347, E1349, E991, E1164
(Illuminant D65, 2° Observer, Annular 45/0 Geometry)
Average of 8 reads, each read oriented 45° apart
Instrument: Hunterlab Colorflex A60 Spectrocolorimeter (No SCF available)

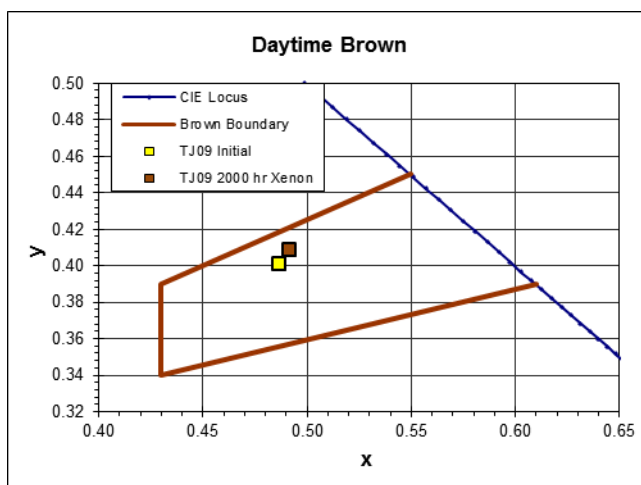
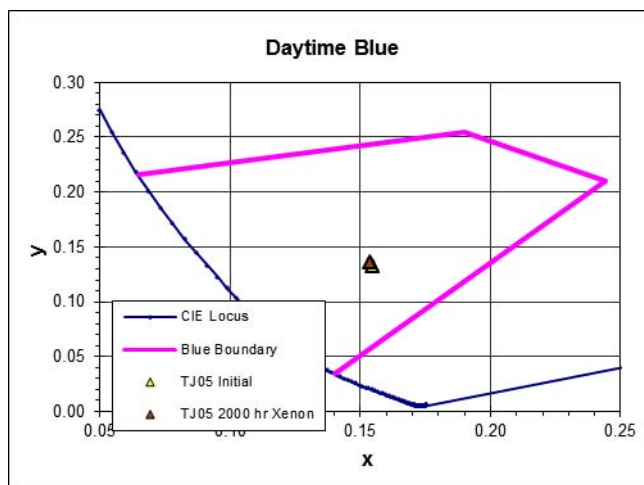
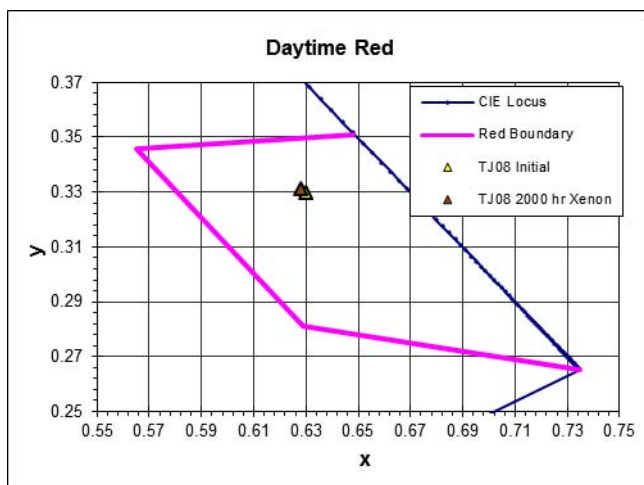
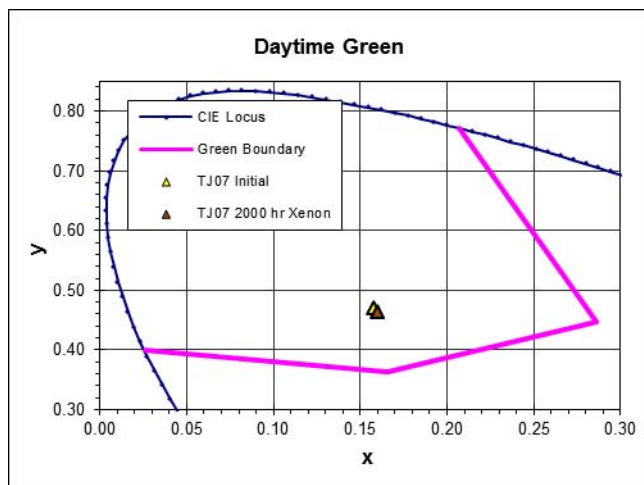
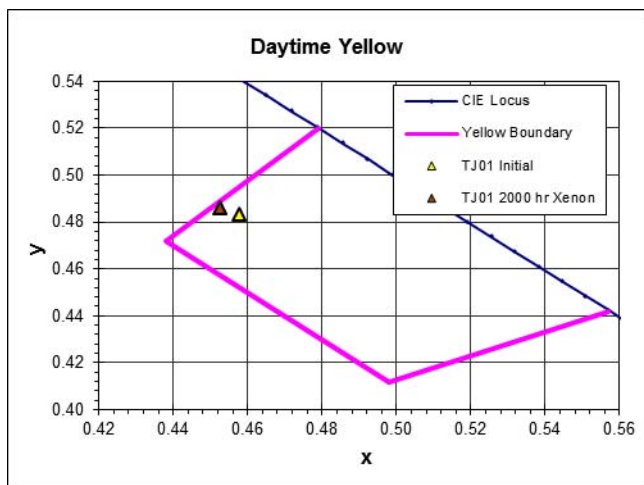
Product	x	y	Y		
			Measured	Minimum	Maximum
TJ01 Yellow	0.4527	0.4856	34.32	15	45
TJ07 Green	0.1604	0.4639	9.22	3.0	12
TJ08 Red	0.6280	0.3308	7.99	2.5	15
TJ05 Blue	0.1539	0.1356	4.96	1.0	10
TJ09 Brown	0.4916	0.4087	3.44	1.0	9.0

Products meet Colorfastness requirements.

Note: See next page for plots against color boundaries.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

Daytime Color Plots

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
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Retroreflective Sheeting (Type IV)

6.6 Shrinkage

Requirement: ASTM D4956 6.6

Test Method: ASTM D4956 7.8

Product	Side	10 minutes		24 hours	
		Measured	Maximum Allowed	Measured	Maximum Allowed
TJ01 Yellow	1	N/C	$1/32$ "	N/C	$1/8$ "
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TJ07 Green	1	N/C	$1/32$ "	N/C	$1/8$ "
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TJ08 Red	1	N/C	$1/32$ "	N/C	$1/8$ "
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TJ05 Blue	1	N/C	$1/32$ "	N/C	$1/8$ "
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TJ09 Brown	1	N/C	$1/32$ "	N/C	$1/8$ "
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	

N/C indicates no change.

Products meet Shrinkage requirements.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.7 Flexibility

Requirement: ASTM D4956 6.7

Test Method: ASTM D4956 7.9

Samples prepared by removing protective liner and liberally applying talc on adhesive side. Samples then bent around $\frac{1}{8}$ " diameter mandrel by grasping long ends of sample and placing center of sample at the mandrel with adhesive side contacting mandrel, then pulling long ends downward and together within 1 second until material had a 180° bend at its center. Samples tested in three (3) orientations - 0°, 45°, and 90° as defined for coefficient of retroreflection.

Product	Results		
	0°	45°	90°
TJ01 Yellow	No cracking.	No cracking.	No cracking.
TJ07 Green	No cracking.	No cracking.	No cracking.
TJ08 Red	No cracking.	No cracking.	No cracking.
TJ05 Blue	No cracking.	No cracking.	No cracking.
TJ09 Brown	No cracking.	No cracking.	No cracking.

Products meet Flexibility requirements.

6.8 Liner Removal

Requirement: ASTM D4956 6.8

Test Method: ASTM D4956 7.10

Samples exposed to accelerated storage conditions of 71°C at 2.5 psi for 4 hours then cooled to 23°C for 1 hour.

Product	Results
TJ01 Yellow	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TJ07 Green	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TJ08 Red	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TJ05 Blue	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TJ09 Brown	Liner easily removed without assistance and did not break, tear, or remove adhesive.

Products meet Liner Removal requirements.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.9 Adhesion

Requirement: ASTM D4956 6.9

Test Method: ASTM D4956 7.5

4" each of two (2) 1"x6" sheeting samples were bonded to 0.040" thick degreased and acid-etched 6061-T6 aluminum panels. After conditioning, a 0.79kg weight was hung from the free end of sample 90° to the panel. After 5 minutes, the peel distance was measured.

Product	Peel Distance		Maximum
	1	2	
TJ01 Yellow	0	0	2.0"
TJ07 Green	0.05"	0 [‡]	
TJ08 Red	0	0	
TJ05 Blue	0 [‡]	0 [‡]	
TJ09 Brown	0.13" [‡]	0.19" [‡]	

[‡] - Adhesive layer remained bonded to substrate. Sample had separation between adhesive layer and adjacent layers. Peel distance, if any, is the layer separation distance.

Products meet Adhesion requirements.

6.10 Impact Resistance

Requirement: ASTM D4956 6.10

Test Method: ASTM D4956 7.11

Samples mounted to 0.040" thick 6061-T6 aluminum and subjected to a 10 in-lb impact from a mass with a steel 5/8" diameter round tip.

Product	Results
TJ01 Yellow	No cracking or delamination outside impact area.
TJ07 Green	No cracking or delamination outside impact area.
TJ08 Red	No cracking or delamination outside impact area.
TJ05 Blue	No cracking or delamination outside impact area.
TJ09 Brown	No cracking or delamination outside impact area.

Products meet Impact Resistance requirements.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

6.11 Nighttime Color

Requirement: ASTM D4956 Table 13

Test Method: ASTM E811, E308

(Illuminant A, 2° Observer, +5°/0.33° Geometry at 10 feet)
Average of 3 reads at $\varepsilon=0^\circ$ and 90°

Instrument: Photo Research PR-650 Spectroradiometer

Initial

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
TJ01 Yellow	0.5408	0.4412	0.5414	0.4409
TJ07 Green	0.2357	0.5657	0.2355	0.5668
TJ08 Red	0.6641	0.3300	0.6635	0.3299
TJ05 Blue	0.1849	0.3263	0.1863	0.3184
TJ09 Brown	0.6206	0.3748	0.6187	0.3765

Post 2000 hr Xenon Weathering (see S3)

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
TJ01 Yellow	0.5325	0.4473	0.5343	0.4460
TJ07 Green	0.2385	0.5464	0.2419	0.5522
TJ08 Red	0.6605	0.3320	0.6606	0.3319
TJ05 Blue	0.1981	0.3143	0.2012	0.3121
TJ09 Brown	0.6152	0.3797	0.6138	0.3805

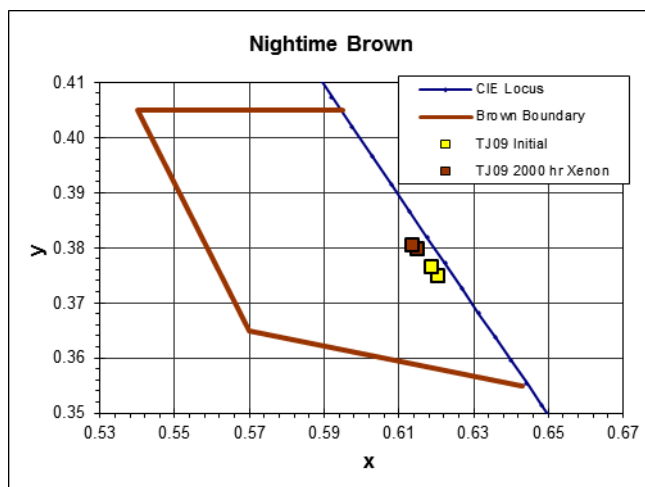
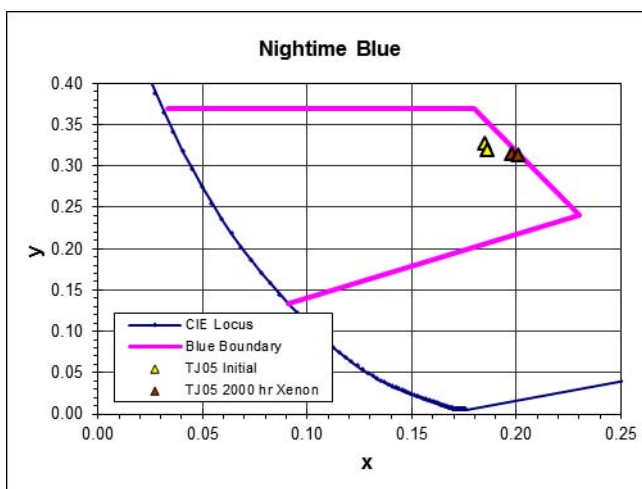
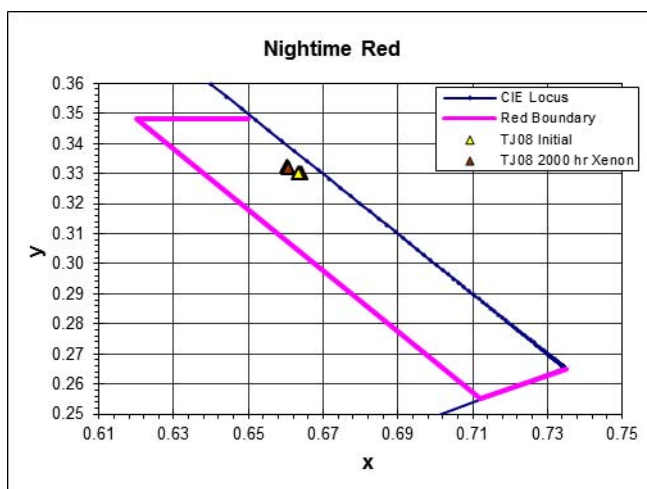
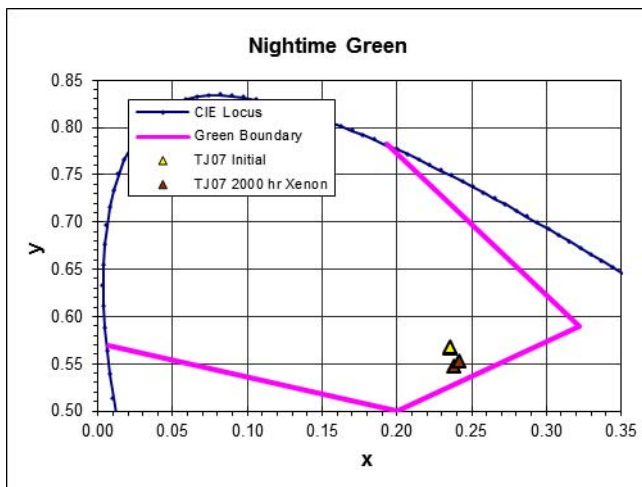
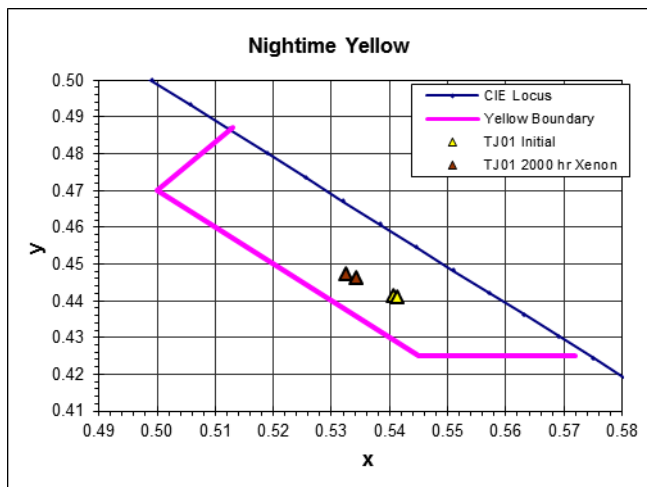
Products meet Nighttime Color requirements.

Note: See next page for plots against color boundaries.

Colorfastness of Nighttime Color is not explicitly required for ASTM D4956.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
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Retroreflective Sheeting (Type IV)

Nighttime Color Plots

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
 + Traffic Jet digitally printed colors + OL-2000 overlay
 Retroreflective Sheeting (Type IV)

Specular Gloss (85°)

Requirement: ASTM D4956-07^{e1} 6.11

*Note: Specular Gloss discontinued since ASTM D4956-09
 Test included for backward compatibility*

Test Method: ASTM D523 (85°)

Instrument: Gardco 85° Glossmeter

Gloss was measured across three (3) orientations ($\epsilon=0^\circ$, 45° , and 90°) and averaged.

Product	Measured				Minimum
	0°	45°	90°	Avg	
TJ01 Yellow	99.6	100.7	100.1	100.1	40
TJ07 Green	97.1	98.1	98.0	97.7	
TJ08 Red	97.9	100.4	99.6	99.3	
TJ05 Blue	100.8	100.7	100.4	100.6	
TJ09 Brown	100.8	100.8	101.1	100.9	

Products meet Specular Gloss requirements.

TEST DATA SHEET

Project Name: Avery Dennison T-6500 White High Intensity Prismatic
+ Traffic Jet digitally printed colors + OL-2000 overlay
Retroreflective Sheeting (Type IV)

S3. Artificial Accelerated Weathering

Requirement: 80% of ASTM D4956 Table 5 (Type IV), 0.2° observation only
Test Method: Exposure: ASTM D4956 S3, Method I
(ISO 4892-2:2006/Amd.1:2009, Cycle 1) - 2000 hours;
ARDL report # PN 120313
Reflex: ASTM E810

Three (3) 3"x6" samples were mounted on 0.040" thick 6061-T6 aluminum panels and exposed for 2000 hours of Xenon Accelerated Weathering per ISO 4892-2:2006/Amd.1:2009 Cycle 1 at ARDL (report # PN 120313). Samples were washed in a mild detergent solution and dried after exposure.

Samples held in place on the two ends of the panel during exposure and thus some areas of the panel were not exposed. A 3" x 5" mask centered over the sample was used to cover unexposed areas. Samples' Coefficient of Retroreflection was measured at two rotation angles ($\varepsilon=0^\circ$ and $\varepsilon=90^\circ$) and averaged.

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

0.2° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg (R _A)	Min R _A	0°	90°	Avg (R _A)	Min R _A
TJ01 Yellow	#1	374.7	358.9	366.8	216	154.6	135.8	145.2	108
	#2	354.3	331.6	343.0		146.3	130.1	138.2	
	#3	367.2	342.1	354.7		145.8	141.8	143.8	
	Avg	365.4	344.2	354.8		148.9	135.9	142.4	
TJ07 Green	#1	167.6	167.5	167.6	40	69.5	73.3	71.4	20
	#2	157.8	155.7	156.8		63.0	67.6	65.3	
	#3	161.6	157.9	159.8		61.9	68.6	65.3	
	Avg	162.3	160.4	161.4		64.8	69.8	67.3	
TJ08 Red	#1	110.2	100.5	105.4	52	48.2	31.1	39.7	24
	#2	109.6	95.2	102.4		43.5	31.9	37.7	
	#3	96.1	81.2	88.7		39.8	27.6	33.7	
	Avg	105.3	92.3	98.8		43.8	30.2	37.0	
TJ05 Blue	#1	81.0	81.2	81.1	24	34.9	35.3	35.1	11
	#2	80.5	80.5	80.5		34.8	35.2	35.0	
	#3	75.9	73.9	74.9		28.9	33.7	31.3	
	Avg	79.1	78.5	78.8		32.9	34.7	33.8	
TJ09 Brown	#1	38.7	40.0	39.4	14	12.0	12.4	12.2	6.8
	#2	39.2	40.4	39.8		11.3	12.6	12.0	
	#3	35.5	35.6	35.6		10.4	10.4	10.4	
	Avg	37.8	38.7	38.2		11.2	11.8	11.5	

Samples show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than $1/32$ " shrinkage or expansion.

Products meet Artificial Accelerated Weathering requirements.

TEST DATA SHEET

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Photographs

